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Awareness Of Agro-Input Materials Impact On Human And Environment In Developing Countries: A Study Of Hoaloc-Mango Farming In Vietnam

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Abstract

The main purpose of this study was to determine human and environmental threats from agro-input materials used in mango farming. The study employed the Environmental Quotient Impact model to measure agrochemical influences on farm-workers, consumers, and the environment through 230 sampling observations in the non-cooperative and cooperative groups in southern Vietnam. The findings show that the cooperative farmer group applies synthetic fertilizer in HoaLoc-mango production more efficiently than the non-cooperative farmer group in seasons, especially nitrogen fertilizer usage, the main source of nitrous oxide emissions, which causes environmental pollution. Additionally, farmer, consumer, and environment EIQ of the cooperative farmer group is better than that of the non-cooperative farmer group. In particular, the environment is the most vulnerable to pesticide overuse. Agro-input material usage was the highest in the first season, followed by the second season, and lowest in the third season.Therefore, agricultural policies need to enhance the progression of collective economics as a good opportunity to control chemical agro-input usage more effectively, raise producers' environmental awareness, and reduce negative impacts on the health of farm-workers and consumers.

Keywords: Environment, fertilizer, pesticide, farm-worker consumer, health.

Introduction

The growing trade in agricultural products in the last few decades has further increased the amount of pollution emitted from the intensification process in producer countries. The agricultural sector is one of the most polluted sources, emitting ammonia and other nitrogen compounds from the production process.

In particular, industrial agriculture relies heavily on agrochemicals such as synthetic fertilizers, herbicides, insecticides, and fungicides (Pingali, 1997; Kimbrell, 2002; Woodhouse, 2010). In 2012, 100 million tons of nitrogen fertilizer was consumed worldwide, and total agricultural energy consumption reached 8,728 petajoules (FAO, 2013). The global synthetic fertilizer demand (N, P_2O_5, K_2O) has increased from 191.9 million tons in 2019 to 200.9 million tons in 2022 (FAO, 2019). Air pollution is one of the most significant environmental issues. Agriculture is considered the prime culprit of air pollution (Erisman et al., 2008; Bauer et al., 2016). The agricultural sector accounts for approximately 70% of the total global water consumption, and is the main contributor of non-point-source pollution to surface water and groundwater and increases soil erosion, salinity, and sediment loads in water due to the excessive use of pesticides and fertilizers (FAO, 2017).

The agriculture sector contributes approximately 30percent of the total global anthropogenic emissions of greenhouse gases (GHGs) (Bouwman, 2001). More attention is now being given to methane(CH4) and nitrous oxide (N2O), as agriculture isresponsible for half or more of the total global anthropogenic emissions of GHGs.Agricultureaffects air quality and the atmosphere by nitrous oxide from chemical fertilizersand manure. In addition, Sheppard et al. (2010) and Hristov (2011) indicated that fertilized land and animal waste are major sources of ammonia (NH3) emissions, accounting for approximately 75% of global emissions (FAO, 2001). The result of ammonia emissions into the atmosphere is contaminant formation (Hamaoui-Laguel et al., 2014). In the European Union, total GHG emissions from agriculture account for 10% of carbon dioxide, methane, and nitrous oxide. In addition, applying agrochemicals (herbicides, pesticides, fungicides, and fertilizers) in production contributes to pollutant dissemination into the air and waterway, and onto nearby land or neighborhoods. As a result, farmers and consumers have experienced health problems such as worsening breathability, daily heat rises, and product consumption of pesticide residues.

This study aims to increase farmers' environmental awareness of agricultural production toward agricultural sustainability. It is important to note that agrochemical overuse is the primary cause of human and environmental threats in the agricultural sector. Hence, agricultural policies that control agro-inputs overuse in the rural and agricultural sectors of developing countries are necessary.

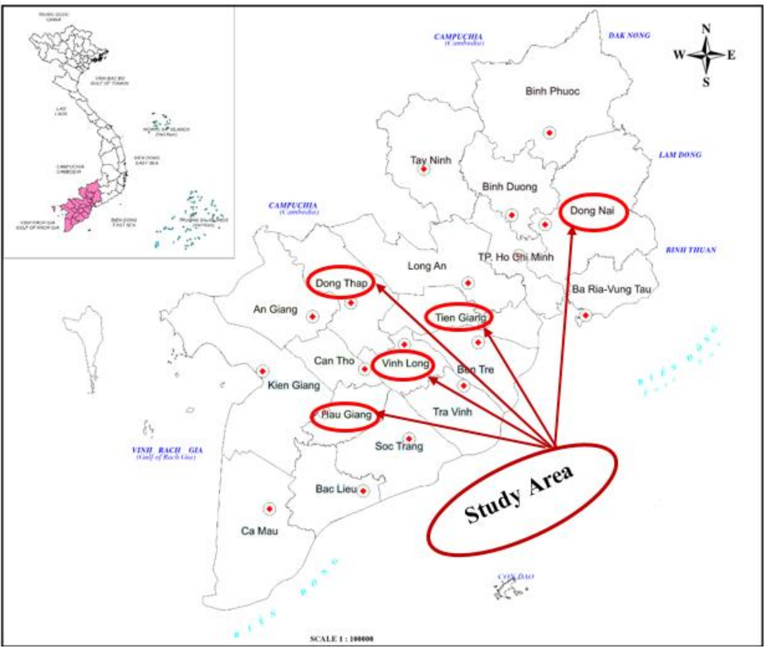
Materials and Methods

Sampling techniques

In Vietnam, HoaLoc-mango is considered the king of mango fruit with high quality, but it is sensitive to soil and climate conditions. Thus, it is only popularly planted in some provinces, such as Dong Nai, Dong Thap, Hau Giang, Tien Giang, and Vinh Long in southern Vietnam. These provinces were also the study area of the research. Primary data were collected via multiple stages. First, the study conducted in-depth interviews with agricultural extension workers at the provincial and district levels to determine the communes of big

HoaLoc-mango farming. Second, ten group discussions were carried out (four people per group) to work out important information before designing the questionnaire. Third, the trial investigation was a pilot survey with 40 sampling observations in five provinces (eight observations in each province). Eventually, a simple random technique was used to collect 230 sampling observations in the non-cooperative grower group (67, 84, and 82 for seasons 1, 2, and 3, respectively), and 191 sampling observations in the cooperative grower group (54, 67, and 70 for seasons 1, 2, and 3, respectively).

Figure 1. Study area



Theoretical model

This study focuses on the EIQ model, an indicator that emphasizes the impact of agrochemical use on humans and the environment by scoring their influences on farmers, consumers, and the environment (Kovach et al. 1992). The EIQ model estimates the hazard of the different pesticides by three score levels, with 1 representing the lowest, 3 intermediate, and 5 the highest. In addition, the model measures the potential risks of pesticide toxicity, such as LD50 (dose at which 50% of the treatment group dies within a specified period) or LC50 (concentration at which 50% of the treatment group dies within a specified time), and the potential exposure such as the half-life, runoff, or leaching potential (Swinton and Williams, 1998) (Table 1).

Table 1. Definition for symbols and ratings for each toxicity category

Variables	Symbol	Score 1	Score 3	Score 5
Long-term health effects (chronic)	C	Little-none	Possible	Definite
Dermal toxicity (Rat LD50)	DT	>2000 mg/kg	200–2000 mg/kg	0–200 mg/kg
Bird toxicity (8 day LC50)	D	>1000 ppm	100–1000 ppm	1–100 ppm
Bee toxicity	Z	Non-toxic	Moderately toxic	Highly toxic

Beneficial arthropod toxicity	B	Low impact	Moderate	Severe impact
Fish toxicity (96h LC50)	F	>10 ppm	1–10 ppm	<1 ppm
Plant surface half-life	S	1–2 weeks	2–4 weeks	>4 weeks
Soil residue half-life (TI/2)	P	<30 days	30–100 days	>100 days
Mode of action	SY	Non-system;	Systemic	
Leaching potential	L	Small	Medium	Large
Surface runoff potential	R	Small	Medium	Large

Source: Kovach et al. 1992; Levitan 1997

The EIQ model refers to the effects of pesticides on three main categories: farmers, consumers, and the environment. For example, farmers (applicators and harvesters), consumers (exposure and groundwater effects), and the environment (fish, birds, bees, other beneficial insects). The EIQ index in the research accounts for these categories using Equation (1).

Table 2. EIQ equation environmental components

EIQ equation component	**Equation**
Farmer (applicator + harvester)	c*((dt*5) + (dt*p))
Consumer (exposure + groundwater effects)	(c*(s + p)/2*sy) + (L)
Environment (fish, birds, bees, other beneficial insects)	(f*r) + (d*(s+p)/2*3) + (z*p*3) + (b*p*5)
Total EIQ = farmer + consumer + environment	
{[c*(dt*5)+(dt*p)]+[(c*(s+p)/2*sy)+(L)+[(f*r)+(d*(s+p)/2*3)+(z*p*3)+(b*p*5)]]}/3 (1)	
Field Use EIQ = EIQ * % active ingredient * rate/ha (2)	

Source: Kovach et al. 1992; Levitan 1997

The field use EIQ is computed based on information on the dose, formulation, or percentage of active ingredient and the frequency of application (Donga & Eklo, 2018). The total impact of all pesticides applied in a cropping season can be estimated by summing up the product of individual fields using the EIQ. This equation is given in Equation (2). In this study, all calculations of the reference EIQ values were performed using Cornell University’s online EIQ calculator in May 2020 (Cornell University, 2020).

Results and Discussion

Table 3 compares the differences in the number of chemical fertilizer use between the non-cooperative and cooperative farmer groups of the three seasons in Vietnamese HoaLoc-mango production. Overall, the non-cooperative farmer group used synthetic fertilizers (N, P, K) higher than the cooperative farmer group. However, there was no disparity in the number of total synthetic fertilizers (N, P, K) in season 1, and this figure is 622 kg/ha for the non-cooperative farmer group and 629.4 kg/ha for the cooperative farmer group. In season 2, the number of synthetic fertilizers (N, P, K) that the non-cooperative grower group (823.6 kg/ha) is approximately double compared with those of the cooperative grower group (417 kg/ha). In season 3, this figure is 2.74 times, in which the non-cooperative and cooperative grower groups are 886.2 and 324.0 kg/ha.

Table 3. The quantity of chemical fertilizer in HoaLoc-mango cultivation in Vietnam Unit: kg/ha

Items	Season 1 Non-coop (n=67)	Season 1 Coop (n=54)	Season 1 T-test	Season 2 Non-coop (n=84)	Season 2 Coop (n=67)	Season 2 T-test	Season 3 Non-coop (n=82)	Season 3 Coop (n=70)	Season 3 T-test
Root fertiliser									
N: nitrogen (kg/ha)	308.0	201.3	ns	323.0	160.7	ns	369.5	128.3	ns
P: phosphorus (kg/ha)	142.5	222.5	ns	288.6	130.4	ns	294.5	102.3	ns
K: potassium (kg/ha)	171.5	205.6	ns	212.0	125.9	ns	222.2	93.4	ns
Microelements (gr/ha)	398.6	17.5	ns	1.0	729.2	ns	0.0	400.6	ns
Leaf fertiliser (Liquid) for flowering stimulation									
N: nitrogen (kg/ha)	9.1	7.2	ns	7.1	4.8	*	6.5	4.9	ns
P: phosphorus (kg/ha)	1.2	0.4	ns	0.3	0.3	ns	0.5	0.3	ns
K: potassium (kg/ha)	5.8	4.6	ns	3.7	3.5	ns	3.3	3.8	ns
Microelements (gr/ha)	90.2	41.3	ns	94.6	55.3	ns	67.3	64.7	ns

Source: Field Survey Data, 2018

* Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level, ns: non-significant

The results in Table 3 are consistent with Phuong's (2020) fertilizer use in Vietnam is 430 kg/ha, which is triple the average global fertilizer use (138 kg/ha). In fruit farming, the demand for nitrogen fertilizer is very high at approximately 48%, while P_2O_5 is 26%, and K_2O is 25%. Agricultural farming also contributes to air contamination. One of the main components that is used widely in agricultural production is nitrogen fertilizers with total global annual nitrogen emissions about 4.7 million tons per year through a variety of agricultural practices and activities, including the use of synthetic and organic fertilizers and production of nitrogen-fixing crops (Mosier and Kroeze, 1998; Schlesinger, 2009). It is a major source of nitrous oxide emissions; however, it is used inefficiently in developing countries (Daberkow, 1999).Nitrous oxide is about 310 times more effective in trapping heat in the atmosphere than CO2 over a 100-year period (Aneja, 2009). It is noticeable that the nitrogen fertilizer consumed in HoaLoc-mango cultivation from the non-cooperative grower category was 1.5, 2, and 3 times for seasons 1, 2, and 3, respectively, greater than the cooperative grower category. The findings indicate that nitrogen fertilizer use in the non-cooperative grower group is inefficient. A study by Mosier (1998) showed that nitrous oxide has harmful effects on the atmosphere and soil. The main source of nitrous oxide emissions is nitrogen fertilizer in agriculture from nitrogen leaching and runoff is nitrogen fertilizer in agriculture. It releases nitric oxide and ammonia, which cause acid rain and soil acidification. This negatively impacts the nutrient absorbability of roots (Baligar et al., 2001). Thus, better management of mango orchards is essential to have wider regulatory measures and effective incentives for balanced fertilizer use and reduce GHG emissions towards sustainable farming for air quality. In particular, nitrogen fertilizers can enter groundwater and surface runoff to prevent nitrate poisoning in the community. For example, dangerous to infants, pregnant women (birth defects and miscarriages), and adults (stomach and esophageal cancers), cause algae blooms, and kill fish by removing oxygen from the water (Ward et al., 2018).

Table 4. The practicalvalues of health and environment impacts (EIQ) in season 1 Unit: kg/ha

	EIQ Component Value						**Average EIQ Value**	
	Farm-worker		**Consumer**		**Environment**			
	Non-coop	Coop	Non-coop	Coop	Non-coop	Coop	Non-coop	Coop
(1) Paclobutrazol	**628.54**	**408.69**	**193.28**	**125.68**	**1,518.23**	**987.19**	**779.92**	**507.12**
(2) Herbicide	**11.10**	**5.06**	**3.43**	**1.62**	**27.35**	**13.86**	**13.96**	**6.84**
Glyphosate	4.32	2.41	1.62	0.90	18.88	10.54	8.27	4.62
Paraquat	1.78	0.60	0.35	0.12	2.00	0.67	1.37	0.46
2.4-D	5.01	2.05	1.46	0.60	6.47	2.65	4.32	1.77
(3) Insecticide	**15.99**	**14.35**	**6.78**	**6.27**	**110.97**	**109.51**	**44.58**	**43.38**
Cypermethrin	9.49	8.07	4.06	3.45	61.47	52.24	25.01	21.25
Chlorpyrifos	0.59	2.08	0.20	0.69	7.08	25.10	2.62	9.29
Emamectin	3.98	2.79	1.77	1.24	29.11	20.42	11.62	8.15
Abamectin	1.76	1.01	0.50	0.28	11.02	6.29	4.43	2.53
Imidacloprid	0.17	0.41	0.26	0.61	2.29	5.47	0.91	2.16
Permethrin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(4) Fungicide	**480.51**	**414.67**	**416.88**	**294.12**	**1,680.70**	**1,249.66**	**859.27**	**652.75**
Mancozeb	273.57	203.17	109.83	81.57	659.13	489.52	347.47	258.05
Propiconazole	154.47	98.86	244.57	156.53	822.54	526.45	407.15	260.59
Ziram	13.69	100.50	5.13	37.69	24.21	177.76	14.34	105.32
Carbendazim	22.78	3.96	36.91	6.41	78.37	13.62	46.02	8.00
Difenoconazole	6.25	3.74	9.80	5.87	35.85	21.46	17.30	10.36
Tebuconazole	3.20	2.74	4.95	4.25	11.19	9.60	6.45	5.53
Azoxystrobin	5.24	0.97	3.91	0.73	43.07	8.00	17.40	3.23
Metalaxyl	0.99	0.71	1.49	1.07	4.54	3.26	2.34	1.68
Trifloxystrobin	0.33	0.00	0.28	0.00	1.81	0.00	0.81	0.00
Field Use EIQ	**1.136.15**	**842.76**	**620.37**	**427.69**	**3,337.26**	**2,360.21**	**1,697.73**	**1,210.09**

Source: Field Survey Data, 2018

Table 4 compares the EIQ values (farmer, consumer, and environment) of the non-cooperative and cooperative groups in HoaLoc-mango farming. In general, four kinds of pesticides are commonly used, such as paclobutrazol, herbicide, insecticide, and fungicide. It is immediately apparent that the number of paclobutrazol and fungicide used was the highest. The finding indicates that the field use EIQ of the non-cooperative farmer group is 1.35 in EIQ farmer, 1.45 in EIQ consumer, and 1.41 times in EIQ environment greater than the cooperative farmer group in season 1.

Table 5. The practicalvalues of health and environment impacts (EIQ) in season 2

Unit: kg/ha

Active ingredient	EIQ Component Value						EIQ Average Value	
	Farm-worker		Consumer		Environment			
	Non-coop	Coop	Non-coop	Coop	Non-coop	Coop	Non-coop	Coop
(1) Paclobutrazol	**292.21**	**345.53**	**89.86**	**106.25**	**705.83**	**834.62**	**362.59**	**428.74**
(2) Herbicide	**9.02**	**4.80**	**2.77**	**1.55**	**22.87**	**15.44**	**11.55**	**7.26**
Glyphosate	3.74	3.06	1.40	1.15	16.34	13.37	7.16	5.86
Paraquat	1.80	1.12	0.36	0.22	2.02	1.26	1.39	0.87
2.4-D	3.48	0.63	1.02	0.18	4.50	0.81	3.00	0.54
(3) Insecticide	**22.32**	**8.78**	**11.44**	**3.94**	**190.78**	**65.18**	**74.85**	**25.97**
Cypermethrin	10.21	2.35	4.36	1.01	66.09	15.24	26.89	6.20
Chlorpyrifos	4.87	0.48	1.62	0.16	58.89	5.79	21.80	2.14
Emamectin	3.16	4.34	1.41	1.93	23.13	31.77	9.23	12.68
Abamectin	1.71	1.28	0.48	0.36	10.70	8.03	4.30	3.22
Imidacloprid	2.37	0.32	3.56	0.49	31.96	4.36	12.63	1.72
Permethrin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(4) Fungicide	**465.67**	**293.06**	**406.08**	**212.39**	**1,551.53**	**920.19**	**807.69**	**475.16**
Mancozeb	214.22	188.03	86.01	75.49	516.15	453.03	272.09	238.82
Propiconazole	133.00	67.90	210.59	107.51	708.23	361.56	350.57	178.97
Ziram	64.11	23.45	24.04	8.79	113.39	41.48	67.18	24.57
Carbendazim	41.32	6.04	66.93	9.79	142.13	20.78	83.46	12.20
Difenoconazole	6.83	4.10	10.70	6.42	39.15	23.49	18.89	11.33
Tebuconazole	3.32	1.00	5.14	1.54	11.61	3.48	6.69	2.01
Azoxystrobin	2.10	1.29	1.57	0.97	17.23	10.63	6.96	4.29
Metalaxyl	0.69	1.26	1.03	1.89	3.14	5.75	1.62	2.97
Trifloxystrobin	0.09	0.00	0.08	0.00	0.49	0.00	0.22	0.00
Field Use EIQ	**789.22**	**652.17**	**510.15**	**324.14**	**2,471.01**	**1,835.43**	**1,256.67**	**937.14**

Source: Field Survey Data, 2018

The results for season 2 (Table 5) show that the field use EIQ of the non-cooperative grower group is more than that of the cooperative grower group in the three cases, including farmers, consumers, and the environment. More specifically, the figure are 1.2, 1.6 and 1.4 times, respectively, for farmers, consumers, and the environment. In particular, there are three active ingredients that are most commonly used in HoaLoc-mango production: paclobutrazol, mancozeb, and propiconazole. They make up approximately 78% of the non-cooperative grower group, and 90% of the cooperative grower group in total all active ingredients using HoaLoc-mango cultivation.

Table 6. The practicalvalues of health and environment impacts (EIQ) in season 3

Unit: kg/ha

Active ingredient	**EIQ Component Value**						**EIQ Average Value**	
	Farm-worker		**Consumer**		**Environment**			
	Non-coop	Coop	Non-coop	Coop	Non-coop	Coop	Non-coop	Coop
(1) Paclobutrazol	**137.65**	**137.06**	**42.33**	**42.15**	**332.49**	**331.06**	**170.80**	**170.07**
(2) Herbicide	**5.28**	**5.84**	**1.55**	**1.97**	**12.69**	**17.94**	**6.50**	**8.59**
Glyphosate	1.99	3.38	0.75	1.27	8.72	14.78	3.82	6.47
Paraquat	1.65	0.11	0.33	0.02	1.85	0.13	1.28	0.09
2.4-D	1.64	2.35	0.48	0.69	2.12	3.04	1.41	2.02
(3) Insecticide	**20.18**	**14.28**	**11.25**	**6.45**	**178.13**	**100.37**	**69.85**	**40.37**
Cypermethrin	8.35	7.94	3.57	3.39	54.03	51.39	21.98	20.91
Chlorpyrifos	4.35	0.24	1.45	0.08	52.59	2.86	19.46	1.06
Emamectin	2.95	4.52	1.31	2.01	21.60	33.05	8.62	13.19
Abamectin	1.54	1.16	0.44	0.33	9.66	7.28	3.88	2.92
Imidacloprid	2.99	0.43	4.48	0.65	40.24	5.79	15.91	2.29
Permethrin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(4) Fungicide	**466.47**	**367.34**	**408.27**	**266.93**	**1,565.11**	**1,149.21**	**813.21**	**594.43**
Mancozeb	233.17	225.33	93.61	90.47	561.80	542.91	296.16	286.20
Propiconazole	130.69	92.08	206.92	145.80	695.90	490.33	344.47	242.71
Ziram	44.64	39.79	16.74	14.92	78.96	70.38	46.78	41.70
Carbendazim	45.69	5.08	74.01	8.22	157.16	17.47	92.29	10.26
Difenoconazole	6.65	3.52	10.41	5.52	38.10	20.19	18.39	9.74
Tebuconazole	2.10	0.74	3.25	1.15	7.34	2.59	4.23	1.49
Azoxystrobin	2.65	0.46	1.98	0.34	21.76	3.78	8.79	1.53
Metalaxyl	0.89	0.34	1.34	0.51	4.08	1.56	2.11	0.80
Trifloxystrobin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Use EIQ	**629.58**	**524.53**	**463.40**	**317.50**	**2,088.42**	**1,598.58**	**1,060.37**	**813.45**

Source: Field Survey Data, 2018

Season 3 takes place under favorable climatic conditions. This does not require the use of too many inhibiting ingredients for mango growth to stimulate flowering. Thus, the number of used paclobutrazol reduced significantly (16% in the non-cooperative gardener group, 21% in the cooperative gardener group) than in season 1 (46% in the non-cooperative gardener group, 42% in the cooperative grower group), and season 2 (29% in the non-cooperative gardener group, 46% in the cooperative gardener group). Moreover, paclobutrazol, mancozeb, and propiconazole are key agro-inputs in HoaLoc-mango production. The proportion of paclobutrazol, mancozeb, and propiconazole accounted for approximately 77% of all agrochemicals in the non-cooperative gardener group and 86% of the total active ingredients in the cooperative gardener group.

In general, the number of pesticides (paclobutrazol, herbicides, insecticides, and fungicides) in season 1 was the highest, followed by season 2, and the lowest was in season 3. The cooperative farmer group used less pesticides than the non-cooperative farmer group in the three seasons. The environmental factor is the most vulnerable to the influence of pesticide compared to farmer and consumer factors among the three seasons. Noticeably, farmers who spray agrochemicals aerially in mango orchards negatively impact their health or even deadly at high doses due to direct and prolonged exposure. The findings of Ngoc (2020) showed that the annual demand for pesticides is 70,000 – 100, 000 tons/year. It rose by 33% compared to the 2001-2010 period. Vietnam is one of the countries with the highest pesticide overuse in the world, at about 4 kg/ha. Vietnamese growers usually use pesticides 5–8 times per crop. This leads to detrimental effects on human health and the environment. According to Ratola et al. (2014), agricultural production releases significant agrochemicals to air quality, and rural regions are potentially more polluted than regions close to industries and urban regions due to air pollution from agrochemicals. Approximately 80%of agrochemicals used in agriculture farming in Vietnam are used incorrectly, causing the release of greater toxicity to the environment (Hoi et al., 2016). Thus, the lack of awareness and scientific studies related to air contamination by pesticides has become increasingly alarming (Souza, 2017). Although agro-input materials can help farmers manage detrimental pests and organisms effectively in production, their negative effects should not be neglected by health complications (especially children and pregnant women), including neural and hormonal chaos, congenital malformation, cancer, and other diseases (CDC, 2009; Magner et al., 2015). Farmers are also susceptible to diseases related to nausea, dizziness, and cancer because they are regularly exposed to various agrochemicals from farming and harvesting processes (Lu et al., 2006; Hoppin et al., 2006).

Conclusion

There are three key active ingredients that HoaLoc-mango growers apply the most popularly, with a substantial proportion comprising paclobutrazol, mancozeb, and propiconazole.

The cooperative farmer group manages used synthetic fertilizer in HoaLoc-mango orchard more efficiently than the non-cooperative farmer group in cropping seasons, especially nitrogen fertilizer, which is a major source of nitrous oxide emissions, resulting in atmospheric and water source pollution. Furthermore, the farmer, consumer, and environmental EIQ of the cooperative farmer group is lower than that of the non-cooperative farmer group. In particular, the environment is the most vulnerable to the overuse of agrochemicals (paclobutrazol, herbicide, insecticide, fungicide). Importantly, farmers who spray agrochemicals aerially in mango orchards are confronted with health threats or even deadly at high doses due to direct and prolonged exposure. Agrochemical usage was the highest in the first season, followed by the second season, and lowest in the third season.

Enhancement of collective economics in the agricultural sector is a good opportunity to control chemical agro-input usage more effectively, raise producers' environmental awareness, and reduce sensitivity to health and the environment. Agricultural policy support cooperation is needed to promote collective economic progression, and has proven successful in the remarkable reduction of agrochemicals in mango production. Importantly, agricultural planners and decision-makers must carefully balance the benefits of humans and the environment, as well as encourage mango growers practicing sustainable agriculture to raise their environmental awareness. This policy would help maintain air quality by reducing the use of chemical agro-inputs that could have a negative impact on humans and the environment.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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